Comparing Phosphorus Uptake of Three Plant Types in Wetland Mesocosms

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Purpose and Background

Purpose

The purpose of this study is to compare vegetative phosphorus uptake in wetland mesocosms among three species of plants, characterized by growth type:

1. A cold season grass, **Canada blue-joint grass** (*Calamagrostis canadensis*)
2. A warm season grass, **prairie cordgrass** (*Spartina pectinata*)
3. A sedge, **tussock sedge** (*Carex stricta*)

Additionally, the vegetative phosphorus content will be compared with the phosphorus content of the soil in the wetland mesocosms.

Background

Wetlands are a type of ecosystem that are saturated with water and contain characteristic vegetation types. They perform many ecosystem services, including water storage and filtration of nutrients, such as phosphorus. phosphorus is often a limiting factor for plant growth, and frequently present in agricultural surface water runoff, as it is used in fertilizer to grow crops [1]. Excess nutrients in water bodies harm the broader aquatic ecosystem, causing eutrophication and poorly oxygenated water. Wetlands can assist with removing phosphorus from the environment by storing it within the vegetation or in the soil [2, 3, 4].

Figure 1. Plants growing in wetland mesocosms.

Figure 2. Mesocosm plants ready for harvest.

Methods and Materials

Plant Growth:

- Plants were grown from seedlings in 30 wetland mesocosms, which are black tubs with a capacity of 100 gallons, on the St. Paul campus, starting in June 2017. Each mesocosm contained one plant species, with 10 mesocosms per species. Plants were harvested in October 2017.

Phosphorus Testing:

- Two plant samples from 18 mesocosms were tested for phosphorus.
- Plant samples were dried at 100°C for 48 hours to obtain their dry weight, then ashed at 550°C for 30 minutes.
- 10 mg of ashed plants were dissolved in 5 mL of 1 N hydrochloric acid, neutralized with 5 mL of 1 N sodium hydroxide, and diluted with DI water.
- 2 mL of this solution was added to Hach TNT 843 Total phosphorus testing kit. Samples were heated, kit reagents added, and testing vials ran through a spectrophotometer to obtain total phosphorus concentration.

Figure 3. Oven-dried plants. Left to right: tussock sedge, Canada blue-joint grass, prairie cordgrass.

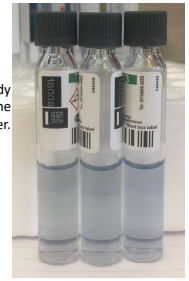


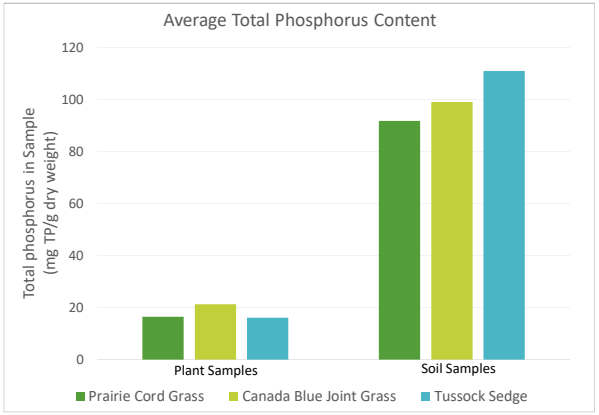
Figure 4. Samples ready to be run through the spectrophotometer.

Results

- Canada blue-joint grass contained the greatest amount of phosphorus, with 30.7% more TP than prairie cordgrass and 32.2% more TP than tussock sedge on average.
- Tussock sedge and prairie cordgrass had approximately the same amount of phosphorus.
- Prairie cordgrass had the highest standard deviation, while Canada blue-joint grass had the lowest standard deviation in vegetative TP contents.
- The lowest value of TP was in prairie cordgrass, at 4.8 mg TP/g plant, and the highest value of TP was also in prairie cordgrass, at 28.5 mg TP/g plant.
- Statistically significant difference ($p \leq 0.05$) was only found between the tussock sedge and Canada blue-joint grass
- All soil samples had more than 5x phosphorus content than all vegetative samples.
- The soil within the tussock sedge mesocosm had the most phosphorus, with 12.1% more than Canada blue-joint grass, and 20.9% more than the soil in the prairie cordgrass mesocosm.

Table 1. Total phosphorus in Vegetation and Soil Samples.

	Prairie Cord Grass	Tussock Sedge	Canada Blue Joint Grass
Total Phosphorus of Plant Species by Mesocosm (mg TP/g of plant, dry weight)	16.6	6.0	15.6
	17.9	18.0	23.1
	28.5	17.2	23.3
	4.8	21.9	22.7
	17.3	16.6	18.5
Average Total Phosphorus in Plant Samples (mg TP/g of dry weight of plant)	**16.4**	**16.1**	**21.3**
Standard Deviation (mg TP/g dry weight)	7.0	4.8	3.1
Total Amount of Phosphorus in Mesocosm (g TP)	**4.3**	**2.8**	**1.8**
Average Total Phosphorus in Soil Samples (mg TP/g of dry weight of soil)	**91.7**	**110.9**	**98.9**
Standard Deviation (mg TP/g dry weight)	6.3	27.7	18.4



Discussion

- Because Canada blue-joint grass had the lowest biomass production, it has the lowest amount of phosphorus on the basis of each mesocosm. In contrast, prairie cordgrass, which had lower phosphorus content on a per gram basis, has more than twice the amount of phosphorus on a mesocosm basis, because it had a much higher biomass production.
- The large difference in amounts of phosphorus in plant matter and soil suggests that phosphorus absorbed by plants is less critical than the phosphorus contained in soil.
- Amount of time (5 months) may have affected the amount of phosphorus determined to be in plant samples.

Conclusions and Future Recommendations

Conclusions

Canada blue-joint grass had the largest amount of phosphorus on a per gram basis, while tussock sedge and prairie cordgrass had the lowest amounts of phosphorus on a per gram basis. However, prairie cordgrass had the highest amount of phosphorus on a per mesocosm basis, while Canada blue-joint grass had the lowest amount of phosphorus on a per mesocosm basis. Therefore, **prairie cordgrass is the most likely to be the most effective at phosphorus attenuation in treatment wetlands**.

Future Recommendations

- Determine time-sensitivity of phosphorus in plant samples.
- Test vegetative phosphorus in full size treatment wetlands.
- Vary growing conditions of plants (climate, water, nutrients, etc.) to determine effect on phosphorus content.
- Test additional species in each plant type, especially warm and cold season grasses.

Acknowledgement

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